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Commentary: Interactivity – agency, pace and attention

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This commentary discusses the article "The meaning of interactivity—some proposals for definitions and measures" by Lars-Erik Janlert and Erik Stolterman (*Human-Computer Interaction* VOL [YEAR], PAGES). This article is very timely as user interfaces are at an interesting nexus between direct manipulation paradigms, which *offer* interactivity, and notification-based systems, which *demand* interactivity. Neither seems to capture the spirit of *man-computer symbiosis* (sic) in Licklider's vision over 50 years ago (doi: 10.1109/THFE2.1960.4503259). This is precisely the *interactability* dimension introduced in the article.

Janlert and Stolterman raise many fascinating issues: for example, the idea of fixed time budgets, although work on early email uptake (Fung , O'Shea & Bly, 1989, http://tinyurl.com/hv9klkl) and anecdotal evidence on Facebook use suggest this may not be true for communication technologies. The article also resonated with so many areas I have worked on in the past and in this commentary I will pick up a few of these threads from my own work and those of others.

When I first read this article I was instantly reminded of my very first conversation with Stefano Levialdi, the father of the HCI community in Italy, who sadly died last year. After a few words of mutual introduction, I recall Stefano, Roberta Mancini and myself sat in Stefano's office at La Sapienza, overlooking Via Salaria, discussing the meaning of interactivity, our conversation ranging from computer interaction: direct manipulation and undo, through human–human interactions with each other and physical interaction with sticks and stones, to the interactions of atoms and sub-atomic particles.

In trying to disentangle interactivity, reactivity and agency, we shifted from formal specification to philosophy in short order and found rapidly that to really understand and define interactivity, rather like Maturana and Varela's *autopoiesis* (*Autopoiesis and Cognition*, 1980), we would need to understand life. We managed to extricate ourselves sufficiently from the intellectual morass to write a short CHI paper on interaction, "Communication, action and history" (*CHI'97*) and for Roberta Mancini to complete her PhD work on undo (http://tinyurl.com/jy2f3fk), possibly the only HCI thesis to include Category Theory proofs.

Janlert and Stolterman have similarly had to manage the tricky mid-ground between philosophical rabbit holes and practical discussion. Crucially, they frame a vocabulary and it is in naming we are able to discuss and obtain intellectual control.

On the issue of agency, which was a key issue in the discussions with Stefano and Roberta, the article suggests that agency is an *essential* part of interaction. If so this would apparently cut out nearly 30 years of direct manipulation dating back to seminal work by Shneiderman (1983, doi:10.1109/MC.1983.1654471) and Hutchins, Hollan, and Norman (1985, 10.1207/s15327051hci0104_2). Arguably, and many artists would attest, even paper and pencil has its own resistance, and this is greater still in constructed materials whether physical, such as Montessori sandpaper letters, or virtual on a computer 'desktop'. The article suggests that to attribute agency to the materials is at best metaphorical, although philosophers of embodiment such as Andy Clark (*Being There*,

1998) would perhaps debate the level of our own agency as we engage with physical materials.

Agency is related to granularity, which ranges from interaction-in-the-small, low-level actions such as typing these words, to interaction-in-the-large, high-level activity such as the human and computer processes and workflows in the publication of an article.

This is partly played out in the issue of attention. In *Keeping Found Things Found*, William Jones (2007) refers back to the 19th century psychological pioneer William James and the 20th century computational pioneer Herbert Simon in seeing attention as a key resource, and maybe even *the* key resource, of human activity. Arguably, without attention there is no agency. However, there is also a great power in automatic actions from a gamer's keyboard shortcuts to a guitar-player's practised fingering.

These low-intention / low-attention interactions are ones that I have studied myself (e.g. in the "Modelling Rich Interaction" chapter of *Human Computer Interaction*, Dix et al, 1987). The area has its own vocabulary, in particular a spectrum of intentionality from explicit intentional acts to incidental interactions (close to implicit interaction), with *expected* interaction, such as the automatic door opening, between. These are not fixed categories: there may be *comprehension*, where low-intention /incidental interactions (such as the brake lights example) become salient and expected, or even *co-option*, when, as with the driver too close behind, they are explicitly manipulated for effect. An important design consideration of this study of low-intention interaction is the notion of two tasks: the primary task the user is intending to do and the secondary task supported by automatic interventions based on the sensing of the primary task.

Granularity also comes to the fore in the discussion of pace (section 3.4). The issue of time in HCI has always been close to my heart, not least "Pace and Interaction" nearly 25 years ago (*Proc. HCI'92*). Janlert and Stolterman talk about a '*window of interaction*' and the problems that arise when the conditions of interaction push towards or beyond the acceptable conditions. For pace, this is close to the notion of matching the pace of the task and communication/interaction channel in "*Pace and Interaction*". Crucially this work showed:

(i) the way human *coping strategies* enable us to operate outside this window, for example having several parallel threads of conversation in an email or posted correspondence; and

(ii) the potential to aid this process, as in Janlert and Stolterman's example of the automated control of flight control surfaces (pace of task faster than human interaction pace) with high-level decisions made by pilot (at appropriate pace for interaction).

Of course studying the former can help us design the latter.

Granularity also surfaces in discussions of continuity and the control space. The issue of continuity has been a recurrent issue in my own studies relating to status–event analysis (e.g. Dix and Abowd, *SEJ* 1996) and physicality

(http://physicality.org/TouchIT/), in particular, the very earliest status-event models were framed to attempt to deal with the discrepancy between the user's feelings of mouse movement being continuous and the system view a series of discrete events. Smooth continuous action seems to be an essential part of artful action, but in *Languages of Art* (1976) Goodman argues that even in the context of music, where virtuoso performance is at the heart, notation needs to be discretised in order to be able to communicate effectively and accurately; indeed, even to be able to say one is playing a particular piece. More generally a central concept in linguistics is the notion of binary opposition originating in Saussure's work (*Course in General Linguistics,* 1906-11); that is the way sounds and words are distinguished into discrete classes for reliable communication.

In fact even in physical human activity, the potentially arbitrary input space offered by continuous muscular and vocal action is limited by Fitts' Law and related properties of the human sensory–motor system. Inspired by Shannon and Weaver's (1963) information theory, Fitts saw his 1954 work on "The information capacity of the human motor system" as demonstrating the fundamental information processing and communication capacity of the human brain. Personally I prefer more cybernetic descriptions in terms of hand-eye coordination, with the accuracy and delays in that system effectively leading to a noisy and hence information-limited channel (http://tinyurl.com/hv6qleo). Indeed one could argue that the series of corrections to obtain more accurate positioning comprises a form of interaction between eye, brain and hand.

More practically, Fitts' Law puts limitations on, for example, the rate of selection from any form of menu or onscreen keyboard. That is, the human *action space* (section 4.1) is *fundamentally limited*; there is a fixed and finite bandwidth between human and machine. However, just as coping strategies help humans cope with mismatches of pace between task and interaction, there are ways in which this fundamental limit can be sidestepped or even shattered.

Section 5.1 notes that the *engaged space* is often far smaller than the *control space*, an observation highlighted in the earliest studies of Unix command use by Hanson, Kraut and Farber (1984). This can be seen as a problem of unused capacity or an opportunity for design. In *The Talking Ape* (2005) Burling argues that reception is more important than production in human–human communication; think about the way a parent makes sense of apparently arbitrary baby sounds, amplifying the child's nascent communication. A context-sensitive control space, such as the classic "Do what I mean" (Teitelman, 1972, doi: 10.1145/1480083.1480119) can be tuned to match the limited human action (and decision) space, increasing the effective interaction capacity in the same way that compression does to an image. That is, context-aware systems are not just about being appropriate, but also an example of optimal coding theory! This can happen adaptively as in context sensitive menus, or in more task-centred interactions such as Henderson and Card's "Rooms" (doi: 10.1145/24054.24056) or what Klujn, in his thesis "*Managing and preserving personal project related information*" (2013) calls task (or project) information management (TIM).

However, coming full circle, the multi-tasking and interruptions caused by notification-based interactions not only divide the user's attention, but may also reduce

the potential for context sensitive interaction. Where notifications must happen, they should ideally include the resources for action (maximising the effective control space), be timed to minimise disruption and/or allow users to easily put them in abeyance until a more appropriate time, which Leavesley and I term Micawber management (doi: 10.21100/compass.v8i12.275).

This re-iterates Janlert and Stolterman's call for design moves to use *interactability* to increase control with reduced interaction. If well-designed computational autonomy can serve to increase user control, we may well see Licklider's vision achieved.

Note, full details of all references can be found at:
http://alandix.com/academic/papers/interactivity-2016/